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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

**KNOWLEDGE PORTAL SUPPORT TO THE NAVAL
POSTGRADUATE SCHOOL'S ADVANCED DISTRIBUTED
LEARNING PROGRAM FOR THE INFORMATION
SYSTEMS AND OPERATIONS CURRICULUM**

by

Allisa M. Walker

December 2000

Thesis Advisor:
Associate Advisor:

Mark E. Nissen
Carl R. Jones

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**KNOWLEDGE PORTAL SUPPORT TO THE NAVAL POSTGRADUATE
SCHOOL'S ADVANCED DISTRIBUTED LEARNING PROGRAM FOR THE
INFORMATION SYSTEMS AND OPERATIONS CURRICULUM**

Allisa M. Walker
Lieutenant, United States Navy
B.S., University of Memphis, 1994

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

**NAVAL POSTGRADUATE SCHOOL
December 2000**

Author:

[Redacted]

Allisa M. Walker

Approved by:

[Redacted]

Mark E. Nissen, Thesis Advisor

[Redacted]

Carl R. Jones, Associate Advisor

[Redacted]

Dan C. Boger, Chairman
Information Systems Academic Group

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ABSTRACT

The Naval Postgraduate School is in the process of migrating the Information Systems and Operations curriculum to a nonresident mode of delivery. Once the migration is complete, there will be a knowledge base available for use by battle staffs as well as policy and acquisition leaders. A knowledge portal may be the solution to facilitating the use of the knowledge base by both learners and operators. The goal of this research is to show how developing a knowledge portal for use with the Information Systems and Operations curriculum knowledge base could expand the use of tacit and explicit knowledge by the operators. By providing access to this repository of information and knowledge, users can capture the most up-to-date knowledge on issues in the world's political and military environment, have the ability to collaborate with experts in the field, and receive answers to questions that will aide in resolving complex issues.

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I. INTRODUCTION

Chapter 1 discusses the purpose and content of this thesis. It also provides an overview of the background and goals of the research, questions addressed, and the methodology used.

A. BACKGROUND

On January 31, 2000, the Department of Defense (DoD) released an initial set of Advanced Distributed Learning specifications and guidelines (DoD Implementation Plan for ADL 2000). They provide the foundation for leveraging learning technologies to prepare a skilled workforce for the future. The Naval Postgraduate School (NPS) has responded to DoD's push for greater learning standards by implementing an Advanced Distributed Learning (ADL) program within its Information Systems and Operations (ISO) Curriculum, with a goal to implement this program throughout the entire NPS curriculum.

The ADL Initiative is DoD's principal vehicle for developing a broad range of plans and programs that use advanced communications and learning technologies to modernize how we educate and train personnel in the U.S. armed forces. The NPS has started to implement this vehicle in its ISO Curriculum in order to provide access to the highest quality education that can be tailored to individual needs and delivered cost-effectively, anytime and anywhere. Through this program, officers who are unable to reside physically at NPS are able to take classes and/or obtain a master's degree.

These ADL architectures house information that can be used not only for degree purposes, but a wealth of information and knowledge exist within the architecture that can be used on a daily basis to aide decision makers in their decision making process. By

providing access to this repository of information and knowledge, users will have at their fingertips, answers to questions, and vital information to aide in resolving complex issues.

The implementation of a knowledge management tool called a knowledge portal appears to be well suited to provide access to this wealth of information located within the ADL architecture at NPS. If successfully implemented, it may allow the ADL program to not only provide an opportunity for advanced education remotely, but also provide the user the ability to capture the most up-to-date information, as well as the latest in research and development on new ideas and decision-making strategies conducted at NPS. It may also provide the war-fighter with a tool that aides in formulating answers to uncertain issues in the world's political and military environment. There is a wealth of knowledge that can be effectively captured and transferred to those that need it most, our war-fighters.

At present, there does not exist an organized method to capture, organize and allow access to the tacit and explicit knowledge residing at NPS. The information and knowledge shared at NPS is not being utilized effectively where it is needed most, on the battlefield. A knowledge portal implemented within the ADL architecture may be the answer to this problem.

The goal of this research is to provide access to information and knowledge, both tacit and explicit, residing within NPS and its ADL architecture to the war-fighter through the use of a knowledge management tool called a knowledge portal.

B. RESEARCH QUESTIONS

The primary research question addressed in this thesis is, “how can a knowledge portal be designed around the Information System and Operation’s Advanced Distributed Learning Curriculum to provide the ability to effectively transfer knowledge to the war-fighter?” The following questions will also be addressed.

- What is a knowledge portal and how does it relate to knowledge management?
- What is the ISO Curriculum?
- What knowledge is needed? When? By whom?
- How can the required knowledge be effectively captured and distributed?
- How can the results from this research be generalized and extended to other sources of knowledge and areas of application?

C. SCOPE OF THESIS

The scope of this thesis includes a review of ISO’s ADL curriculum at NPS, an in-depth review of knowledge management with an emphasis on knowledge portal technology. An evaluation is conducted to assess how a knowledge portal can be designed for the ADL curriculum. A requirements assessment is done to identify the users and define what information and knowledge requirements are necessary. The education process is also be mapped to understand how it would change through the use of a knowledge portal. Due to the limited number of courses presently in the ADL mode, this thesis is limited to the assessment of one ADL developed course. Recommendations made address the entire ISO ADL curriculum based on the findings from this research.

D. RESEARCH METHODOLOGY

The research techniques used for this thesis include a thorough literature review of knowledge management, a review of the ADL architecture designed for the ISO Curriculum, and a review of the requirements process used by users and stakeholders of the system being developed. Such users and stakeholders include: The Joint Information Operation Center, J39, and Information Operations cell officers. A knowledge management framework is used to analyze and design a knowledge portal to aide in the transfer of knowledge from NPS to the war-fighter.

E. CHAPTER OUTLINE

This thesis is organized as follows. Chapter II provides background information on knowledge management and knowledge portals, along with a description of the ADL architecture used by the ISO curriculum at NPS. Chapter III identifies the users and their requirements, and it identifies the current architecture used to share information. Chapter IV uses a framework designed by Nissen, Kamel, and Sengupta to develop an effective knowledge management portal that offers good potential to benefit the users. Chapter V closes with conclusions, recommendations and potential future research topics.

II. BACKGROUND

A. INTRODUCTION

Today, in most organizations, large and small, there is strong interest in identifying optimal strategies to leverage the intellectual capital of the organization's workforce. The Department of the Navy (DoN) is no exception. Increasing the capability of knowledge workers for agile, effective decision-making in fast-changing environments requires not only robust connectivity and infrastructure, but also organizational culture and processes that nurture and facilitate intensive levels of information sharing that in turn will lead to a larger common knowledge base and to evolve new knowledge (Reneker and Buntzen 2000).

In June 1999 the Secretary of the Navy, the Chief of Naval Operations (CNO) and the Command Master Chief (CMC) jointly released the DoN Information Management and Information Technology Strategic Plan for fiscal years 2000-2001. This plan consists of four goals, one of which addresses how to use our investments, calling for the implementation of strategies that facilitate the creation and sharing of knowledge to enable effective and agile decision making (Bennett 2000).

Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information (Davenport and Prusak 1998). It is a high-value form of information that is ready to apply to decisions and actions. Given the importance of such an asset, it is not surprising that organizations everywhere are paying attention to knowledge – exploring what it is and how to create, transfer, and use it more effectively (Davenport, De Long, and Beers 1998). The power of knowledge is no longer attributed

solely to successful individuals in a company, but is also recognized and pursued at the enterprise level through a practice called knowledge management (Davenport and Prusak 1998).

Chapter II provides background information on knowledge management (KM), knowledge portals, and distributed learning as it pertains to the ADL architecture designed for the ISO Curriculum.

B. KNOWLEDGE MANAGEMENT

Many prominent technology firms in the commercial industry are investing in Knowledge Management (KM). World-class companies such as Shell and IBM have embraced the importance of knowledge as a competitive advantage in the global marketplace. Consistent with this industry recognition, KM initiatives are emerging at every level of the DoN. Due to the wide spread use of KM amongst different disciplines, its various definitions range from the practical, through the conceptual, to the philosophical, and from the narrow to the broad in scope. Although each definition has some variance and uniqueness that's relevant to the discipline it applies to, they all have a common thread: the objective of enabling an organization to improve its results or operations by developing a framework, discipline and IT-supported practice for collecting, vetting and sharing enterprise knowledge (Abramson 1999). Table 2.1 provides a few of the definitions used to describe KM.

Each of these experts share a common idea that knowledge management is gathered for the purpose of applying it within the organization in some way that results in making proper decisions or fulfilling objectives.

Author	Definition
Wiig	KM is the systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge assets.
Hibbard	KM is the process of capturing a company's collective expertise wherever it resides - in databases, on paper, or in people's heads – and distributing it to wherever it can help produce the biggest payoff.
Petrash	KM is getting the right knowledge to the right people at the right time so they can make the best decision.
Macintosh	KM involves the identification and analysis of available and required knowledge, and the subsequent planning and control of actions to develop knowledge assets so as to fulfill organization objectives.

Table 2.1: Knowledge Management Definitions (From Liebowitz 1999)

Knowledge is part of a continuum moving from data, through information and on to knowledge. In order to effectively manage knowledge, it is important to be able to distinguish it from data and information. Data is a set of discrete, objective facts, pictures or numbers about an event. Information is a message, usually in the form of a document or an audible or visible communication that is meant to change the way the receiver perceives something, to have an impact on his/her judgment and behavior (Davenport and Prusak 1998). Knowledge is simply information in action or context, together with an understanding of how to use it (O'Dell and Grayson 1998, Brooking 1999).

Knowledge in organizations range from the complex, accumulated expertise of individuals, which is partly or largely inexpressible, to much more structured and explicit content (Davenport and Prusak 1998). This vast range of knowledge can be categorized as tacit or explicit. Explicit knowledge is formal, documented knowledge that is readily accessible in forms such as publications, documents, databases, textbooks, web sites, manuals, tables and training materials. In a well-known and frequently cited Harvard

Business review article titled “The Knowledge Creating Company,” Ikujiro Nonaka refers to explicit knowledge as “formal and systematic” and offers product specifications, scientific formulas and computer programs as examples. Tacit knowledge is found in the heads of employees and in the experiences of customers. Because it contains insights, intuitions, and hunches, tacit knowledge is highly personal, hard to formalize, and deeply rooted in a person’s actions and experiences as well as in their ideals, values and emotions (Cho, Jerrell, and Landay 2000). The KM challenge in the DoN, and most other companies, is to discover and capture its tacit knowledge (that contained in our people), share this knowledge through enterprise-wide connectivity, and leverage Corporate Knowledge (that which is visible or explicit) (Bennet 2000).

According to many KM experts, KM can be described in terms of attributes that flow through a structured process or life cycle, which begins at its conception or creation, and continues until it has completely evolved into a useful state of sharing and application. There are many different KM life cycles. Table 2.2 outlines the most prominent life cycles proposed by KM experts in the literature (Nissen 1999, Despres and Chauvel 1999, Gartner Group 1999, Davenport and Prusak 1998). Notice these models share considerable similarity.

Model	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Nissen	Capture	Organize	Formalize	Distribute	Apply	
Despres/Chauvel	Create	Map/bundle	Store	Share/transfer	Reuse	Evolve
Gartner Group	Create	Organize	Capture	Access	Use	
Davenport/Prusak	Generate		Codify	Transfer		
Amalgamated	Create	Organize	Formalize	Distribute	Apply	Evolve

Table 2.2: KM Life Cycle Models (From Nissen, Kamel & Sengupta 2000)

Through integration of the 4 life cycle models above, the 6 phases of the Amalgamated Life Cycle Model that results include: 1) create, the discovery and development of new knowledge (Despres and Chavel 1999, Gartner Group 1999); 2) organize, which involves organizing, mapping or bundling of knowledge (Nissen 1999, Gartner Group 1999); 3) formalize, which concentrates on making knowledge explicit (Nissen 1999); 4) distribute, the ability to share knowledge (Nissen 1999); 5) apply, the ability to use the knowledge in the organization (Nissen 1999); 6) and evolve, the refinement and continual development of existing knowledge (Despres and Chauvel 1999). This KM life cycle model provides a useful framework for differentiating between knowledge and its management, as it flows through various stages.

C. KNOWLEDGE PORTALS

The rise of Internet technology has resulted in a frustrating experience for nearly everyone using the web. The simplest web search, the most basic knowledge work, involves the coordination of myriad sources of data, processes, and people, not to mention the integration of a multitude of desktop, enterprise, and web technologies (Koulopoulos 1999). One of the goals of KM is to provide the right knowledge to the right people at the right time. The process of ensuring knowledge is flowing effectively throughout the organization, and that it is readily available, is part of the distribution phase of the KM life cycle. Some of the tools used to allow distribution and sharing of knowledge are groupware, lessons learned, "yellow pages", best practices, frequently asked questions, discussion groups, teleconference, email, search engines, and workshops (Nissen, Kamel, and Sengupta 2000). The knowledge transfer method chosen for an organization should suit its organizational culture (Davenport and Prusak 1998).

One form of knowledge transfer is through the use of a knowledge portal. A knowledge portal provides users one-stop shopping for essential information and knowledge components needed to accomplish knowledge work (Cho, G., Jerrell, H., and Landay, W. 2000). Knowledge portals, in other words, provide knowledge about a business or other enterprise, and they can also provide meta-knowledge that can be useful for decision making.

Portals have garnered more attention than virtually any other Internet technology over the past year. Some have gone so far as to call portals the next generation of desktop computing, saying that portals will do for global knowledge-work what the railroad did for the industrial revolution (Koulopoulos 1999). There are many different types of portals in use in organizations today. Some of the current portal software available include web/Internet portals, enterprise information portals, enterprise knowledge portals, and corporate/intranet portals. A brief summary of each is presented in turn.

1. Web/Internet Portals

An internet portal is a comprehensive value added website which acts as the “reference librarian of the Internet, directing web surfers to desired destinations” (Meehan 1998). It is a gateway to the World Wide Web. Any page with a link to another Web site can technically be considered a web portal. However, a good web portal will provide links to all the information that is important on a daily basis. For example, a web portal with interest to the author should provide links to recent news stories, current weather reports and forecasts, stock quotes, sport scores, and other timely information. There are several Web sites that can provide this information, and most can be

customized to meet individual needs. For a site to become a successful portal on the Internet, it must include the four essential characteristics of a portal: content, communication, community and commerce. A brief explanation of each is described below.

It is vital for an Internet portal to contain content that is current, detailed and reliable. Because Internet portals are beginning to partner with other information sites to provide an array of information to consumers, they must ensure that the information that they are providing is appropriate and of use to the consumer. This information is usually grouped into directories by content type which allows the consumer to browse through information in his or her area of interest (e.g. travel or music), and eliminates the hassle of time consuming searches that lead to dead-end results. Some corporations will tailor an Internet portal using content that is specific to a user's particular interests.

Communication tools provide the interactivity that makes the Internet so different from any other communication source. Communication is the essential tool to encourage users to interact and exchange information and ideas. These tools include email, message boards, forums, chat lines and newsgroups which allow users to find and interact with other users. These communication tools provide the basis for building a community on the Internet and allowing its members to interact and exchange information on an Internet portal.

The final characteristic of an internet portal is commerce. Commerce is the ability to exchange goods and products. Because industry appears to be moving towards electronic commerce (the ability to buy, sell and pay for goods and merchandise over electronic means), it is important for Internet portals to have the capability to support this

endeavor. Electronic commerce is not emerging as quickly as expected due to some consumer concerns about security of payment over a public network. These issues are being resolved and a number of electronic commerce options are now becoming available (Warner, 1999). Referring back to the amalgamated model above, web/Internet portals are employed principally in support of knowledge distribution.

2. Corporate/Intranet Portals

A corporate/intranet portal (sometimes called Enterprise Information Portal) is a site structure that provides efficient search mechanisms to a specific corporation.

Corporate portals generally provide more efficient access to information than searching the external Internet. An intranet portal contains the same functionality as Internet portals (e.g. search capabilities, organized directory based content, news, links to related websites) but are also inwardly focused, simple and efficient, not necessarily requiring the gimmicky graphics of the commercial websites. Corporate portals support powerful search tools that allow the organization's internal content to be indexed and accessible via the site. The intranet portal requires menu driven systems to access the corporate applications traditionally available on an intranet system.

Corporate portals also provide organized links to related organizations, competitors and trade links, which provide staff with easy access to information that they require on the external internet, reducing their search time and making their internet use more efficient. The intranet portal is a critical tool for knowledge management within an organization. The sheer volume of information that is contained now on intranet web sites is beginning to overwhelm many organizations. An intranet portal can provide structure and organization to this data; turning data into information and information into

knowledge (Warner 1999). Referring back to the Amalgamated Model above, corporate/intranet portals are employed principally in support of knowledge organization, as well as distribution. It is this additional organization aspect that gives the corporate intranet portal its added value.

3. Enterprise Knowledge Portals

Enterprise Knowledge Portals (EKPs) are goal-directed toward knowledge production, knowledge acquisition, knowledge transmission, knowledge management, and focused on enterprise business processes (e.g., sales, marketing, risk management). An EKP distinguishes knowledge from mere information, and it provides a facility for producing knowledge, which orients an organization toward producing and integrating knowledge rather than information (Firestone J.M. 2000). Some of the systems used to provide the services listed above are included in Artificial Knowledge Management Systems (AKMS) whose components include computers, software, networks, electronic components, etc.

A specific type of AKMS is the Distributed Knowledge Management System (DKMS), which is designed to manage the integration of distributed computer hardware, software, and networking objects/components into a functioning whole that supports enterprise knowledge production, acquisition, and transfer processes. Content Management, Business Intelligence, Data Warehouse/Data Mart, and Knowledge Management are other applications that EKP use to integrate information and knowledge into a single system that can share, manage and maintain information from one central user interface (Firestone J.M., 2000).

Content Management Systems process, filter, and refine unstructured internal and external knowledge contained in diverse paper and electronic formats, archive and restructure it, and store it in a corporate repository. Business Intelligence tools access knowledge through querying, reporting, on-line analytical processing (OLAP) and data mining. And analytical applications provide a view of information both presentable and significant to the end user. Data Warehouses and data marts are integrated, time-variant, non-volatile collections of data supporting decision support systems and enterprise information system applications. Knowledge Management Systems perform tasks, clean data, and facilitate scheduling, administration and metadata management for data warehouses and data marts. For example, the Artificial Knowledge Manager will place a heavy emphasis on criteria used to test and validate the knowledge produced or acquired by the Enterprise Knowledge Portal (Firestone J.M., 2000).

Gerry Murray, IDC's Director of Knowledge Management Technologies states: The enterprise knowledge portal (EKP) is an evolution of the portal that is influenced by the goals of KM. It combines enterprise information portal (EIP) aspects while also capturing tacit knowledge, integrating access to expertise and embedding application functionality. The EKP not only provides the means for information access, but lets users interact to link information with their collective insight, value and experiences. EKPs enable people to make optimal decisions as EKPs combine acquired knowledge and information, and serve as a "self-documenting" center of experiential learning.

EKP differs from the above mentioned portals in that it distinguishes knowledge from mere information, and it provides a facility for producing knowledge from data and information. Because corporations are managing knowledge instead of information, they provide a better basis for making decisions, and have a competitive advantage over those who are managing information. Referring to the amalgamated model above, EKPs are

employed in knowledge organization, formalization, distribution and knowledge evolution.

4. Summary

As can be seen from the descriptions above, all portals fulfill the distribution phase of the amalgamated KM life cycle model by providing a single entry point to vast amounts of structured information and knowledge. They all specialize in providing a means to share or distribute knowledge to users. However, users must be careful when categorizing portals, and understand that all portals aren't knowledge portals. In order for a portal to be categorized as a knowledge portal, it must provide the right content in a meaningful manner, as well as have goals directed towards knowledge organization, knowledge distribution, and knowledge management (Firestone, 1999).

The Web/Internet portal provides access to all data, information and knowledge available on the Internet. It is principally employed in support of the knowledge distribution phase of the amalgamated KM life cycle only. Because its users include anyone with access to the Internet, it is hard for Internet portals to provide meaningful knowledge to each person. Most Internet portal search results yield a vast mixture of data, information and/or knowledge that the user has to sort through. Internet portals provide little, if any, customization and personalization for each user.

Corporate/Intranet and Knowledge Enterprise Portals are designed for a specific group of users, and are able to provide more specific meaningful information and knowledge using powerful, robust search engines. They are both employed in more areas of the KM life cycle including knowledge organization, formulization, distribution and evolution.

D. ADVANCED DISTRIBUTED LEARNING

Distributed learning has been practiced for many years, with its first inception in the form of print-based correspondence courses. Correspondence courses were a useful attempt to solve the problems of geographic dispersal of students for specialized courses, usually involving technical content. The late 1960's and early 1970's brought educational television and a new generation of distance learning methods. The era was exemplified by open universities, which combined television, radio, and telephone with print media. Today video and audio conferencing, email, FAX, and computer-based integrated telecommunications systems are defining a third generation of distributed learning technologies (Chief of Naval Education and Training 1998).

The proliferation of personal computers in the home and work place offers new opportunity and potential for distributed learning. Recent advances in networking technology and telecommunications have revolutionized the availability and speed of information access and now enable individuals to interact seamlessly over the Internet and other networks. Distributed, object-oriented, multimedia training applications, as well as point-to-point videoconferencing technology, are also enabling courses to be taken without regard to location or space (Chief of Naval Education and Training 1998).

This offers good potential in the Navy, as the structure and inflexibility of the current education and training system is now significantly impacting operational readiness. Changes in mission and operations, as well as advances in weapon systems technology, have significantly increased the performance demands on naval personnel. To support these challenges, the Navy's education and training programs are changing,

attempting to ensure naval personnel keep pace with the latest technology and are prepared to accomplish critical network-centric information warfare mission requirements. The implementation of advanced distributed learning (ADL) will be an investment in operational readiness (Navy Distributed Learning Planning Strategy 1998). The Navy ADL architecture will be a corporate communications system that supports formal and organized education and training programs, as well as provide the capability to exchange information.

NPS is developing a network-based learning architecture for the ISO curriculum. In 1999, the Commander, Naval Education and Training (CNET), provided initial funding to make components of the ISO curriculum available using ADL. This program has been developed due to a perceived urgent need to facilitate and make available the theories and practices of Knowledge Superiority throughout the Fleet. The NPS ADL architecture contains a web-based educational service designed to integrate theory and practice related to Knowledge Superiority in naval and joint operations (Teleologic 2000).

The design and implementation of DL courses for the ISO curriculum will be based on asynchronous and/or synchronous technology, whichever provides the learner with the optimum course experience. Some of the technologies that are used in a synchronous learning environment include: Video Teleconference (VTC), multiple VTC, document cameras, and teleconference links. These technologies are often grouped and termed an "electronic classroom" as shown in Figure 2.1 (NPS Distributed Learning

Migration Plan 1999). Asynchronous technology includes internet-based tools, chat-rooms, Email, CD-ROMs (CBT), and basically any technology that affords the learner

- **The “Electronic Classroom”:**
 - Big screen Video Tele-Conference capability**
 - Document Cameras**
 - Multi-use, configurable student area**
 - **Computer Learning**
 - **Interactive Learning**
 - **Classical Learning**
 - **Discussion Circles**
 - Multi-Media capability**
 - Multiple Site capability (Bridging)**

Figure 2.1: The Electronic Classroom (From NPS Distributed Migration Plan 2000)

with 24 hour, at-your-own-pace, 7 days a week accessibility. NPS has been proactive in the use of asynchronous technologies, using the term “Network Based Learning” (NBL) as shown in Figure 2.2 (NPS Distributed Learning Migration Plan 1999).

- **Network Based Learning**
 - Utilize web technologies**
 - Multi-media capable**
 - Widely available – PC and browser based**
 - Learner-centric: available when Learner is available (24 x 7)**
 - Fully reproducible**
 - Learner audience limited only by Web accessibility**
 - Feedback for course development can be built-in**

Figure 2.2: Network Based Learning (From NPS Distributed Migration Plan 2000)

Both synchronous and asynchronous technologies have some tradeoffs that must be analyzed in order to choose the learning environment that is most suitable for the learner.

Figure 2.3 outlines some of the tradeoffs for both technologies.

Both technologies provide access to information, education, and focused communications to enhance understanding and application of Knowledge Superiority as a strategic pillar of U.S. national security. The use of these technologies can equip officers with the ability to create innovative strategies and policies, agile organizational structures

Synchronous Pros	Asynchronous Pros
Closer to “classical” lecture paradigm Utilizes current available technologies “Richer” teaching potential Expanded student audience	Available now - 24x7 Less expensive than synchronous Reach very large Learner audience Easily modifiable Course feedback more quantifiable
Synchronous Cons	Asynchronous Cons
Must be “scheduled” – not learner centric Hard to reproduce – “one time” experience Limited by available VTCs and bandwidth Interactivity has constraints Hard to get quantifiable course feedback	Not a panacea New paradigm for educators Requires technical capability to implement Some topics require socialization

Figure 2.3: Synchronous and Asynchronous Pros and Cons
(From NPS Distributed Migration Plan 2000)

and decision processes responsive to real time mission and situation requirements, understand information technology and systems, and integrate technology, organization, policy and strategy into an Information Operations framework useful in deliberate and crisis planning and execution across the range of military operations (Teleologic 2000).

E. CONCLUSION

The awareness of the value of knowledge to an organization, coupled with its management, acts as an integrator that improves cross-organizational communication and cooperation. Using a knowledge portal to communicate and share knowledge between, as well as within, organizations enables a knowledge-centric environment where people can make and implement effective and agile business decisions.

III. USER REQUIREMENTS

A. INTRODUCTION

In order for any knowledge management process to be effective, it must fulfill the needs of all potential users and stakeholders having access to the system being developed. This chapter discusses potential users of the NPS ISO knowledge portal, their requirements and the processes being used to meet those requirements.

B. USERS AND STAKEHOLDERS

Information Operations (IO) is one of the key ingredients for knowledge superiority. It involves actions taken to affect adversary information and information systems, while defending one's own information and information systems, whether human or automated (Joint Doctrine for Information Operations 1998). Joint Force Commanders (JFC), the Joint Information Operation Center (JIOC), Information Operation Cells (IO cells) and other key IO decision makers are continually faced with ambiguous and regionally focused threats. They may confront a variety of factors that challenge the stability of countries and regions and threaten US national interests and security. These instabilities can lead to increased levels of competition, a wide variety of attempts at intimidation, drug trafficking, insurgencies, regional conflicts, and civil war. It is difficult to predict when such threats will emerge. (Joint Pub 3-13) For this reason, they need to have access to intelligence that is timely, accurate, usable, complete, relevant, objective and sufficiently detailed to support an array of IO requirements. Many different capabilities and activities must be integrated to achieve a coherent IO strategy that will meet these requirements.

C. USER REQUIREMENTS

It is important to understand the requirements of the users. Requirements for IO are determined by the JFC and contained in their objectives and operations concepts.

Examples of IO objectives are depicted in Figure 3.1.

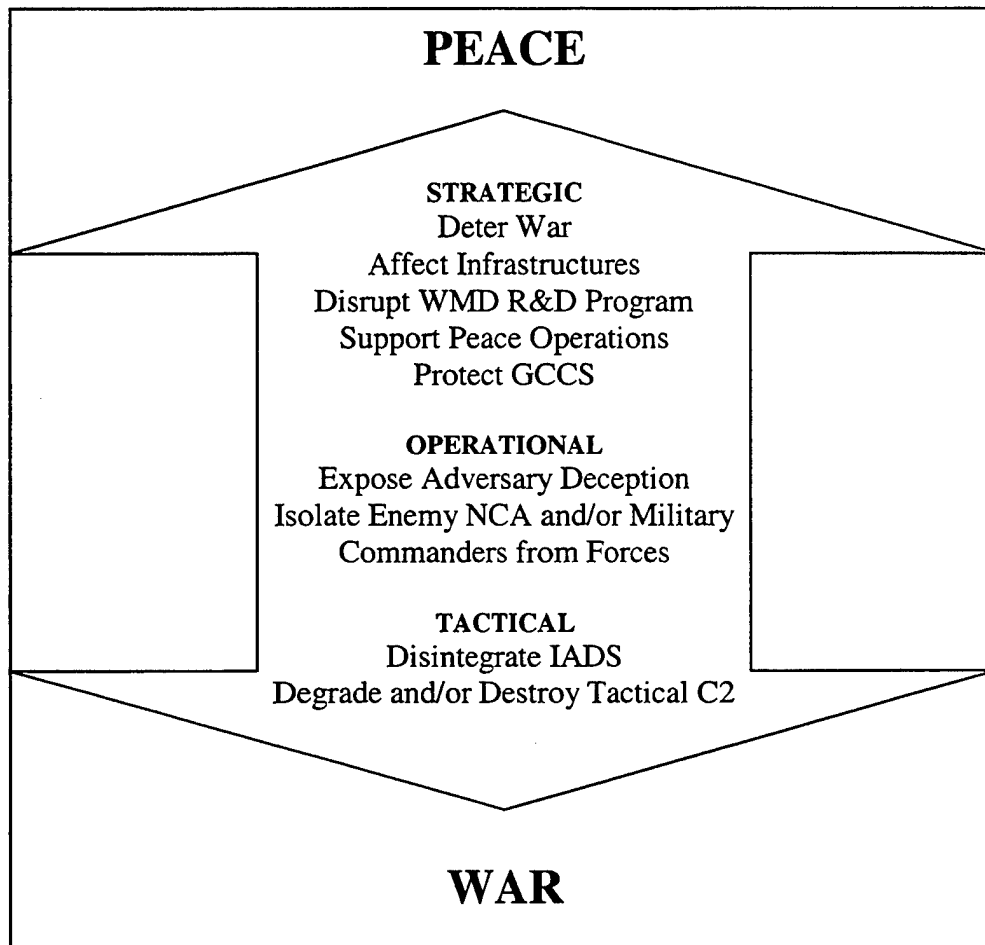


Figure 3.1: Examples of Information Operations Objectives (From Joint Pub 3-13)

These requirements are influenced by, and revised as, potential threats to US national interests and security changes. These requirements are a part of an overall planning process called the Joint Operation Planning and Execution System (JOPES). JOPES uses

two separate planning process guidelines, one for deliberate planning which is a general guide to IO planning, and the other for crisis action planning, which is usually used in crisis situations where the time periods for decision making are compressed. (Joint Pub 3-13) Tables 3.1 and 3.2 contain the phases and planning action for the two JOPES planning guidelines.

Notice IO requirements are developed in phase II of the deliberate planning process, and phases I and II of the crisis action planning process. The requirements that are incorporated into the deliberate and crisis action planning are submitted to the Chairman of the Joint Chiefs of Staff for validation. Once the requirements are developed and validated, they are termed target sets and communicated to the Intelligence Community, who support IO by providing precise and timely intelligence using IO support databases. (Joint Pub 3-13)

D. IO REQUIREMENTS FULFILLMENT PROCESS

IO cell operators take target sets and search and analyze the databases and templates created by IO supporters to determine the vulnerabilities and critical elements of friendly and adversary information, information-based processes, and information systems. Examples of potential IO targets are shown in Table 3.3. (Joint Pub 3-13)

Within the military infrastructure target set, IO operators will search for information using computers, communication networks, databases and other reliable assets containing resources which will aid them in understanding how to attack adversary information systems with the goal of rendering them useless in a crisis situation. Some of the specific information needed includes how to reduce adversary bandwidth (how much

PLANNING PHASE	JOPEs	IO CELL PLANNING ACTION	IO PLANNING OUTCOME
PHASE I	Initiation	Notify IO cell members of planning requirements	N/A
PHASE II	Concept Development		
Step 1	Mission Analysis	IO cell identifies information requirements needed for mission planning.	Tasking to gather/obtain required information
Step 2	Planning Guidance	IO cell assists in development of combatant commander's IO planning guidance to support overall operational planning guidance.	Combatant commander's planning guidance for IO.
Step 3	Staff estimates	IO cell supports the development of intelligence, operations, and communications staff estimates.	IO portion of staff estimates.
Step 4	Commander's Estimate	IO cell assists in transforming staff estimates into the Commander's Estimate.	IO portion of Commander's Estimate.
Step 5	Combatant Commander's Concept	IO cell assists in the IO aspect of Combatant Commander's Concept as required.	IO portion of Combatant Commander's Concept
Step 6	CJCS Concept Review	IO cell assists in the IO aspect of CJCS Concept Review as required.	IO portion of operational concept approved by CJCS.
PHASE III	Plan Development	IO cell develops the complete IO plan and the plans for each of the IO elements in coordination with appropriate staff sections, operational units, and supporting agencies.	Draft offensive and defensive IO appendices with element tabs.
PHASE IV	Plan Review	IO cell modifies/refines plan as necessary.	Approved offensive and defensive IO appendices.
PHASE V	Supporting Plans	Subordinate units and supporting agencies prepare their own IO plans. IO cell coordinates/assists subordinate and supporting IO plan as necessary. Ensure TPFDD supports IO plan.	Completed subordinate and supporting agencies' supporting plans. IO plan supported by TPFDD. TPFDD=Time-Phased Force and Development Data CJCS=Chairman of the Joint Chiefs of Staff

Table 3.1: IO Planning Related to Deliberate Planning (From Joint Pub 3-13)

PLANNING PHASE	JOPEs	IO CELL PLANNING ACTION	IO PLANNING OUTCOME
PHASE I	Situation Development	IO cell identifies planning information requirements as situation develops.	Tasking to gather/obtain required information
PHASE II	Crisis Assessment	IO cell identifies information requirements needed for mission planning. IO cell assists in development of combatant commander's IO planning guidance to support overall operational planning guidance.	IO planning guidance. Initial liaison with units and agencies that may participate in or support IO operations.
PHASE III	Course of Action Development	IO cell supports the development of intelligence, operations, and communications staff estimates.	IO portion of staff estimates.
PHASE IV	Course of Action Selection	IO cell assists in transforming staff estimates into the Commander's Estimate. IO cell assists in the IO aspect of Combatant Commander's Concept as required.	IO portion of overall plan approved through CJCS.
PHASE V	Execution Planning	IO cell develops the complete IO plan and the plans for each of the IO elements in coordination with appropriate staff sections, operation units, and supporting agencies.	Approved offensive and defensive appendices with element tabs, completed supporting plans, and inclusion of IO requirements in TPFDD.
PHASE VI	Execution	IO cell monitors IO operations and adapts IO objectives to support changing operational directives.	IO objectives modified as necessary to support changing operational objectives.

Table 3.2: IO Planning Related to Crisis Action Planning (From Joint Pub 3-13)

LEADERSHIP Civilian Military Social Cultural	MILITARY INFRASTRUCTURE Communications Intelligence Logistics Operations
CIVIL INFRASTRUCTURE Telecommunications Transportation Energy Finance Manufacturing	WEAPONS SYSTEMS Aircraft Ships Artillery Precision-Guided Munitions Air Defense

Table 3.3: Examples of Information Operations Targets (From Joint Pub 3-13)

information can pass), throughput (how fast information flows), fidelity (accuracy of received message), increase error content (error fraction on system), degrade update (reduce completeness of the message), defeat hardness (physical and nonphysical protection), defeat overall security of system, defeat security processes (processes that protect the system), and defeat detection (enter and operate without detection). (Deckro, Doyle, Kloeber, Jr., and Jackson 2000) This is only one of many different target sets that IO operators will need to understand in order to meet requirements that prepare them to effectively engage the adversary in crisis situations.

E. SOURCES OF INTELLIGENCE

IO requirements are very diverse, which makes it very hard, if not impossible, to retrieve all requirements from one source. The Joint Publication for IO, Joint Pub 3-13, understands the vastness of information resources available to IO operators, and has designed a worldwide infrastructure of communication networks, computers, databases, and consumer electronics, called the Global Information Infrastructure (GII), that makes

vast amounts of information available to users. This interconnection of resources, as depicted in figure 3.2, includes cameras, scanners, keyboards, facsimile machines, computers, switches, compact disks, video and audio tape, cable, wire, satellites and satellite ground stations, fiber-optic transmission lines, networks of all types, televisions, monitors, printers and other types of equipment that are used to store, process, and display information.

The National Information Infrastructure (NII) is similar but is used on a national information environment, which includes all government and civilian information infrastructures, and the Defense Information Infrastructure (DII) is embedded within and deeply integrated into the NII. The DII is the shared or interconnected system of computers, communications, data applications, security, people, training, and other support structures serving DoD local, national, and worldwide information needs. (Joint Pub 3-13) These infrastructures ensure that the knowledge that is contained within the different organizations are realized and used to support the user requirements.

The DII provides a standard environment, "off-the-shelf" software, and a set of programming standards called the Common Operating Environment (COE) that describe in detail how mission applications will operate in the environment. The COE contains common support applications and platform services required by mission applications. Each application that is migrated to the common environment must comply with published guidance described in the Integration and Runtime Specification. (C4I For the Warrior Brochure

The DII is a part of the overall Global Command and Control System (GCCS). The Assistant Secretary of Defense (C3I) established the GCCS as the principal migration path for defense-wide command and control systems, directing that GCCS

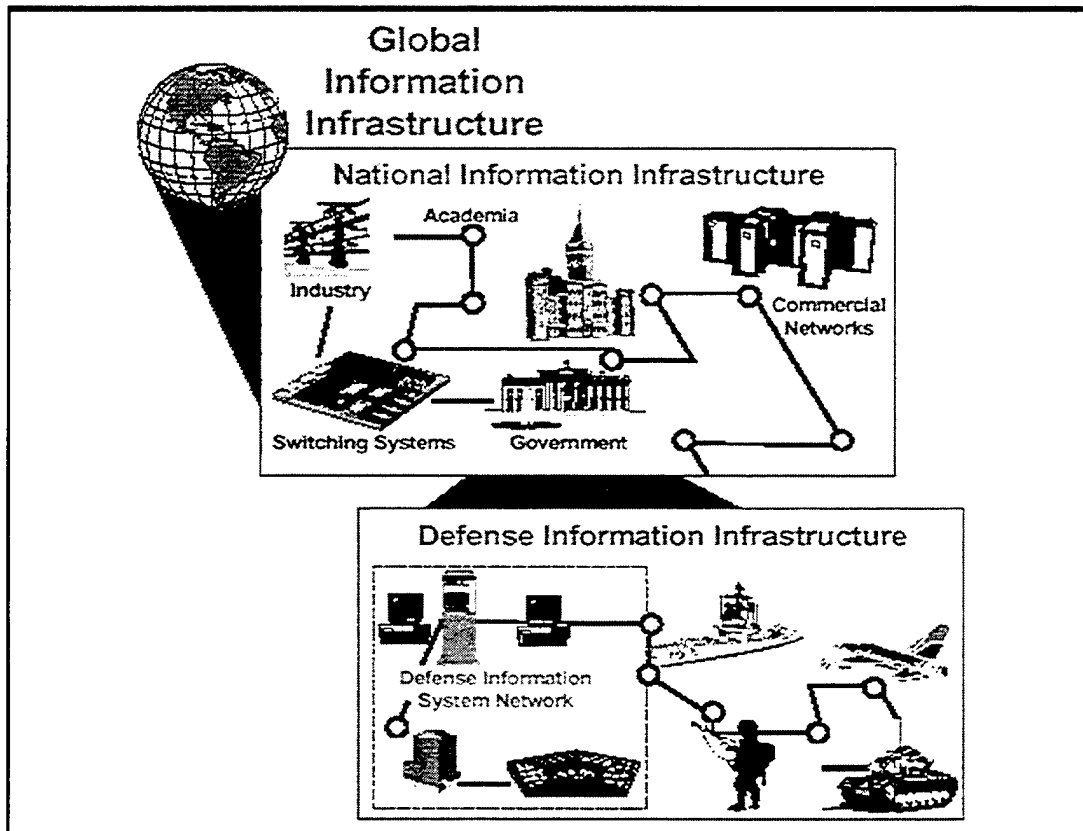


Figure 3.2: GII-NII-DII Interface (From Joint Pub 3-13)

rapidly and efficiently deliver to combatant commanders C2 capabilities through maximum use of commercial off-the-shelf and government off-the-shelf components. GCCS is composed of several mission applications built to a single common operating environment (COE) networked to support sharing, displaying, and passing information and databases. The GCCS infrastructure consists of a client server environment incorporating UNIX-based servers and client terminals as well as personal computer (PC) X-terminal workstations; operating on a standardized local area network (LAN). The

GCCS infrastructure supports a communications capability providing data transfer facilities among workstations and servers. Connectivity between GCCS sites is provided by the Secret Internet Protocol Router Network (SIPRNET), the secret layer of the Defense Information Systems Network (DISN). (C4I For the Warrior Brochure)

The GCCS architecture consists of a suite of relational database and application servers. Some of the standard application interfaces that will be available using the GCCS include network administration, database management, communications, on-line support, distributed computing, data interchange, security administration, system administration, file management, message processing, network services, mapping toolkit, and other applications. Using standard data eliminates redundancies and stove-piped systems, and provides a common base to facilitate information exchange, reducing time needed to set up a basis for data communication. The Services, combatant commands and agencies used JOPES as the starting point for standardizing data, since JOPES data model encompasses data requirements for many of the applications that would be included in the GCCS. (C4I For The Warrior Brochure p7)

GCCS testing is based on a process of continuously evaluating the comprehensive system. The testing process continues to track the progress of GCCS throughout its integration and installation phases. It occurs concurrently as additional functional blocks are added to the system. The process provides a complete, accurate, and timely evaluation of the system. The results from the testing support GCCS in areas like providing information on how well a candidate system operates in the GCCS environment, supporting system integration decisions; providing feedback to determine satisfaction of user requirements and facilitate changes to GCCS. The testing process

verifies that GCCS meets the stated requirements of the users, and ensures that GCCS remains interoperable and fully integrated. (C4I For The Warrior Brochure p12)

F. RAPID ACCESS TO IO INFORMATION

One example of a system designed to meet the requirements of JFC, JIOC, IO cell, and other key decision makers is the Rapid Access to IO Information (RACI) developed by the Information Base Branch at JIOC. RACI is a web-based virtual data bank containing links to IO information to support theater information operations. Every country in the world is addressed in RACI and is structured by IO elements and other general intelligence data. RACI provides a single conduit for IO information in a user-friendly format. IO information is catalogued in a standardized manner that allows not only ready access to IO information, but also helps to identify what is, and what is not available.

RACI uses the Sensitive Compartmented Information (SCI) and Secret Collateral services of Intelligence Link (INTELINK) and SIPRNET functions as the intelligence community architecture for sharing and disseminating intelligence. RACI ensures automation of intelligence as much as possible to provide as much knowledge and information sharing as possible. Any information in hardcopy form only is placed online so that everyone has access to it. RACI also uses online textual search and retrieval systems to aid users in locating the information they need in a timely fashion. They also provide hyperlink applications to direct users to other resources that meet stated user requirements. The Information Base Branch constantly analyzes and updates intelligence sources by using a working group called Information Base Working Group (IBWG) to meet with all IO related intelligence and operational organizations to access the status of

IO information support to the war-fighter. Through this forum, Information Base Branch personnel are able to get feedback on what requirements are not being fulfilled and define actions to address those deficiencies. The Information Base Branch re-verifies IO information requirements continuously to ensure that the information they are providing meets the needs of the users. (Morris 2000)

G. CONCLUSION

As described above, IO and the tools used to meet its stated requirements enable commanders and other leaders to make informed decisions by providing them with knowledge that is precise, detailed, timely and up-to-date. In order to support this IO concept, the NPS ISO knowledge portal must be interoperable, flexible, reliable, and secure.

Knowledge portals must possess the interoperability necessary to ensure IO success during conflict or crisis situations. Interoperability allows knowledge to be accessible and exchanged directly and satisfactorily between the knowledge portal and its users. Flexibility is required to meet changing situations and diversified operations with a minimum of disruption or delay. It is important for the knowledge portal to be flexible enough to adapt quickly to new information requirements or changing technology. In order for IO to be successful, knowledge must be available when needed and the system providing this knowledge must be reliable and perform as intended. This includes functioning with low failure rates, ensuring timeliness of information as well as redundancy in the event of failure. Incorporating security measures to prevent unauthorized users from accessing the system and its contents is also an important attribute to a well developed portal that meets the needs of the IO users described above.

Developing a knowledge portal into the new ADL course for the ISO curriculum can provide JFC, JIOC, IO cells and other key decision makers an array of open source knowledge and detailed resources tailored to their IO requirements that will aid them in making decisions in a timely manner. The new ADL ISO curriculum will use the requirements generated by the IO cell and the JIOC, as described above, to develop a growing database of information and knowledge to help fulfill their requirements. At the same time, this increased wealth of knowledge within the ADL curriculum will allow the faculty to teach students using knowledge resources that are relevant to current military situations.

IV. SYSTEM DEVELOPMENT

A. INTRODUCTION

Knowledge is critical in conducting offensive and defensive IO, and IO operators require support, coordination, and participation by other United States Government departments and agencies to be effective in achieving knowledge superiority. Faculty in the ISO curriculum at NPS are involved in extensive studies in the theory and practice of IO. They ensure students are educated in the concepts of IO, to include an appreciation of the vulnerabilities inherent in their information systems and the opportunities found in adversary systems (Joint Pub 3-13). In order to provide students with an educational experience that is relevant to their future jobs, the NPS ISO curriculum uses current real world situations and intelligence as learning tools that allow students to analyze information and use it to make intelligent decisions to maintain battlefield dominance and knowledge superiority.

This chapter addresses the ability of the NPS ISO curriculum to provide a wealth of knowledge to the IO community, namely IO cell operators, using a knowledge portal. This chapter looks at the different phases of the KM life cycle and the systems, practices and principal enabling information technologies that best fit this knowledge portal. This chapter also looks at a knowledge portal design that can be incorporated within the NPS ISO curriculum.

B. KNOWLEDGE MANAGEMENT LIFE CYCLE

In Chapter II we discuss the different phases of the amalgamated KM life cycle, and its importance in system design. This section presents different information tools and

technologies that can be implemented at each phase of the KM life cycle to achieve an effective knowledge portal.

1. Create

The creation of knowledge includes knowledge acquired by an organization as well as knowledge developed within it (Davenport and Prusak, 1999). Knowledge creation for an organization can not be successful if user requirements are not well defined. Chapter II also outlines how user requirements are determined. For this system, the user requirements are constantly changing, so it is important that knowledge is continually being created to ensure user needs are fulfilled.

The ISO knowledge portal can obtain its knowledge a number of ways. First, the faculty responsible for the ISO curriculum contains a wealth of tacit knowledge obtained from past experience in similar occupations. They understand the user requirements, and the type and format of information and knowledge the user is seeking to make informed decisions. The faculty is able to capture the knowledge needed by users and make that knowledge available when needed. For example, faculty can use advanced data analysis by incorporating “knowledge” mining, On-Line Analysis Processing (OLAP), correlation, influence diagrams and other advanced technologies to glean valuable insight from stored information, to produce a knowledge-based product that enables improved decision making. The faculty will also be available through email and video teleconferencing to aid users in meeting requirements.

Second, the ISO curriculum can provide an expertise database, or knowledge base, that is updated with information and knowledge to meet users’ requirements. This knowledge base will be constantly updated with new knowledge as it becomes available.

This knowledge is captured from knowledge currently available in manuals, reports, articles (incorporated in the on-line database), intranets, the Internet and other knowledge stores.

Third, the ISO curriculum can provide an expertise locator and collaboration function that allows users to search and retrieve the information they desire, resulting in increased collaboration and interaction between common interest groups. The expertise locator provides the ability to find, catalog and make available the best expertise available in the DoD for analysis in support of decision making. Collaboration enables people to share information, expertise, and insights, which results in an amplification of tacit knowledge, which could lead to enhanced innovation and motivation (MORS, 2000).

2. Organize

It is very important that the knowledge available within an organization have some structure and organization that allows easy access and sharing with its users. The use of knowledge maps to organize knowledge within the knowledge portal can provide the user ease in retrieval of needed resources. A Knowledge map is simply a detailed table of contents that represents knowledge sources (people and information nodes) in a context defined by their relationships. It could be an actual map, a knowledge "Yellow Pages," or a uniquely constructed database. Developing a knowledge map involves locating important knowledge in the organization and then publishing some sort of list or picture that shows where to find it. Knowledge maps point to people as well as to documents and databases (Davenport and Prusak 1999).

A knowledge portal can also be organized using a knowledge administrator. The administrator is a powerful Java application with a Web-based, graphical interface. The administrator allows operators to manage the entire information cycle, from object creation and definition, to data links and end-user accessibility. This graphical tool gives the operator the ability to control individual user profiles, security levels, and report objects, including definition of portal categories. The administrator can be installed as a Windows application or it can operate within a Web browser. (Brio Technology 2000)

A specialized database, or knowledge base, can be used to organize and store information and knowledge within the knowledge portal. Metadata is used within the knowledge base to effectively tag knowledge so that it can be retrieved when needed. Knowledge is separated into modular components, or objects, that can be stored and retrieved according to their content. When the information and knowledge is entered into the database, it is tagged with content information like title, comments/keywords, author, owner, date of obsolescence, applicable country, security classification (in this case all information will be unclassified) and category. This facilitates search and allows automatic updating when new content supercedes older content. A user seeking information or greater understanding on a topic can activate a window on a display that will open Web linkages, or pointers, to a distributed knowledge base (Ackerman 2000).

For example, a user seeking information on a region would touch the target site and navigate through different types of information. The user could learn about airfields by viewing actual images, review runway information, and scan terrain data. (Ackerman 2000) The user could also obtain a better understanding of the current political, social and economic issues that could possibly affect future decisions by the leadership in that

region. Any civil wars, neighboring conflicts would all be available to give the user greater knowledge on the region in question. All this knowledge would be drawn seamlessly from a number of diverse sources to give the user specific and tailored knowledge to enhance his/her ability to visualize the situation and ensure total operational awareness.

On-line Yellow Pages or an electronic database of knowledge workers can be made accessible within the knowledge portal. Some potential sources of experts to populate the on-line yellow pages include previous IO cell operators who are skilled and knowledgeable in the field, NPS faculty and other known subject matter experts that are knowledgeable in IO issues. Users will have the ability to search by topic or key word, making it easy to locate and compare potential knowledge sources (Davenport and Prusak 1999).

3. Formalize

Knowledge formalization involves making knowledge explicit or formal. Most of the knowledge that users will access in the NPS ISO curriculum will already be represented in some explicit format. Content format include reports generated by experts in the field, lessons learned, documents and publications, organizational doctrines, hyper-linked web sites, intelligence articles and other knowledge sources needed to meet user requirements. These knowledge sources will be accessible electronically via the knowledge portal, and stored as objects or components according to their content, in a knowledge base or knowledge repository. The use of objects and components to store knowledge provides a modular reuseable approach that allows for rapid recombination of information generated to provide knowledge useful in making key decisions.

Users will also have access to the on-line ISO distributed learning course where they can gain valuable insight and understanding of the IO process and how to make key decisions. This course provides a wealth of knowledge on IO topics like how operators take knowledge sources and make key decisions using the orient, observe, decide and act (OODA) loop. By accessing this course, users will become more prepared, and feel more comfortable making decisions using knowledge sources made available to them. Of course, through the ability to contact and interface with IO subject matter experts (e.g., at NPS), their tacit knowledge will also be available. And expected queries to the same experts or on the same topics may provide the impetus required to have the corresponding tacit knowledge made formal (e.g., through a document or new course module).

4. Distribute

Once the knowledge is available on-line, users can retrieve that knowledge through the knowledge portal. Knowledge portals are unique in their ability to present knowledge from diverse sources through a common interface. Regardless of where the content originates from (e.g., databases, knowledge components or repositories, hyper-linked Web sites, on-line news articles, the Internet, e-mail), users will have access to it through the knowledge portal. The knowledge portal will contain a user interface which allows users to select appropriate “hot buttons” on a screen that will direct them to Web linkages or the knowledge base to retrieve the requested knowledge. The knowledge contained within the knowledge portal will be based on the requirements generated by the users.

If the users cannot find the specific topic needed, they will have the option of typing in specific topics using the robust search option on the user interface. A

compilation of knowledge available within the knowledge portal on the requested topic will become available to the user. As described above, the use of metadata in storing knowledge will allow access to queries that are complete, detailed and up-to-date. The user will have the ability to browse through the resources available, and choose the information that is useful at that time.

Users will also have access to tacit knowledge using e-mail, telephones and video conferencing. Experts in the field can be identified through the yellow pages designed on the system. The yellow pages will contain a list of all experts in particular fields of interest to the user. Name, address, telephone number, email address and other contact information will be located in the yellow pages. Faculty and other experts in the IO field will be able to answer user specific questions using the e-mail function accessible through the knowledge portal. A video conferencing time can also be arranged with users using NPS advanced technology distance learning equipment. If users need instant feedback, or have questions that need real-time response, knowledge can be distributed via telephone conversations.

5. Apply

Apply refers to the application or reuse of knowledge for problem solving or decision making in the organization (Nissen 1999). This phase of the knowledge management life cycle provides potential for tacit knowledge to be transferred and applied by the users when needed. Through the use of video conferencing, email and telephone conversations, users and experts can discuss how knowledge can be applied to situations to achieve the best possible solution. NPS knowledge portal workers can use the same communication systems, or schedule meetings with users to ensure knowledge

generated and made available within the NPS ISO knowledge portal is being used appropriately to satisfy requirements.

6. Evolve

Depres and Chauval define evolve as the refinement and continued development of knowledge. This process is very important in the IO community. Requirements as well as available knowledge are constantly changing. In order to stay abreast of the latest events and requirements generated, the NPS knowledge portal must continually evolve and remain updated. It is also important to understand the users, what knowledge is useful to them, and tailoring the knowledge portal to meet their needs.

The knowledge portal also has potential to evolve as new knowledge sources become available. Knowledge workers should always be aware of new sources of knowledge available to meet user requirements, and make those resources available in a timely manner. Also the knowledge portal must be flexible to changes in technology. Staying abreast of new and improved ways of efficiently conducting business is important in keeping the user satisfied. As new technology emerges, NPS should become aware of its pros and cons and make informed decisions on improving its capability to meet user requirements.

The knowledge portal also has the potential to be expanded to other courses and curriculums. As other curriculums become available through the ADL curriculum, an assessment can be made as to how that information and knowledge can be used to increase war-fighters decision making ability. Identifying how courses like Space Technology, Mathematics for ISO and Communications and Countermeasures can

benefit the warfighter in real-world operations is essential in ensuring users have access to as much information and knowledge available from NPS as possible.

7. Summary

There are numerous examples of IT transformations that can be incorporated into a successful knowledge portal. The technologies that would best suit the users of this particular portal are listed above, and summarized in Table 4.1. Most importantly, the architecture designed for the knowledge portal must remain flexible and evolvable to allow for quick migration and integration of new applications and technology.

Create	Organize	Formalize	Distribute	Apply	Evolve
Faculty	Knowledge Maps	Knowledge Base	Knowledge Portal	Video teleconferencing	Collaboration
Expertise database	Knowledge Administrator	ADL Course	Search Engine	Email	
Collaboration	Knowledge Base		Email	Telephone	
			Telephone	Meetings	
	Yellow Pages		Video teleconferencing		

Table 4.1: KM Information Technology Tools

C. CONCEPTUAL DESIGN OF KNOWLEDGE PORTAL

There are many different ways to design a knowledge portal. Finding and developing the portal that fits your organizational needs is important, and will ultimately decide if users use it. A knowledge portal must be built on sound architectural principles to ensure scalability to meet the needs of a growing user population, capability to evolve

with the implementation of new technology, provide security, availability and most importantly, meet the user's requirements. This section will present a knowledge portal design that meet the needs of the intended users.

1. Multi-Tier Web-based Portal Architecture

This portal design is fashioned after the Brio Technology portal and is based on a multi-tier architecture that uses middle-tier service brokers to handle communications between clients and back-end services. This portal architecture uses cooperative back-end services to store, manage, and deliver knowledge objects. Each service handles a specific activity and is designed to ensure a scalable, broad-based reporting and knowledge delivery system. As shown in Figure 4.1, these service agents include a Web Client, Service Broker, Name Server, Repository, and Job Factory, and will be described in detail in the following paragraphs. (Brio Technology 2000)

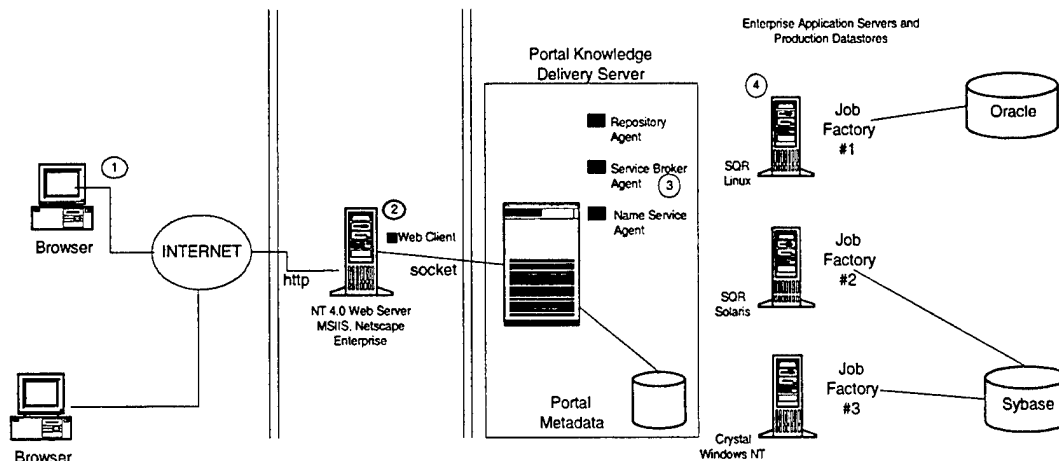


Figure 4.1: Knowledge Portal Architecture (after Brio Technology 2000)

The Web Client is a server-side component that dynamically extends the Web server. A user starts a Web browser and then through HTTP protocol connects to the Web client with the appropriate user name and password. The use of a Web browser provides interoperability between other systems. From within the Web Client, the user can browse and download objects, run jobs or view job output residing in the portal system. The users' view of the portal is based on their permissions and the permissions set on the objects. The Web Client is responsible for accepting and reviewing HTTP requests, delegating work, and presenting the results in the form of Hyper-Text Markup Language (HTML) pages and HTTP replies. (Brio Technology 2000)

The primary role of the Service Broker is to provide overall session management for the portal. Clients do not directly connect to any other portal service. The Service Broker sets up and maintains each end-user connection, relieving other services from this resource-intensive processing requirement. Client Server requests are routed to the appropriate portal service. Work is also distributed amongst portal services that support identical services to provide dynamic load balancing and backup services. This improves performance and reliability since two machines can process Job Factory requests in parallel. The Service Broker is responsible for authenticating user connections and maintaining secure user sessions. It acts as an application firewall, where clients cannot connect directly to a portal service, but must go through the Service Broker, which then routes the request to the appropriate service. (Brio Technology 2000)

The Name Server provides a directory lookup service to all portal services by managing user information. It provides a list of the valid users and groups defined within the portal. Each service then authenticates users requesting a connection using this list.

The Name Server keeps user names and passwords in the Relational Database Management System (RDBMS). The Name Server encrypts the passwords in the database so that a user with database access cannot view the passwords in clear text. A super user can reassign a user a new password if they have forgotten their password.

The Repository provides storage management services for a variety of knowledge objects including graphics, executables, reports and report output, queries and their results, and related information objects like HTML files, word processor, spreadsheet, desktop OLAP files, and any other related document or program. The Repository responds to user initiated inquiries to store, retrieve, search, and browse, as well as process requests and return the results to the user. (Brio Technology 2000)

The Repository also contains an information object catalog that is stored in the RDBMS. The objects are separately maintained by the Repository in a file system. Meta-data about these objects control permissions, description, keywords, version, expiration date, category hierarchy, and relationships between objects are also kept in the Repository. The Repository's tree-like structure of user defined content categories allows the user to navigate down categories and subcategories to search for knowledge. (Brio Technology 2000)

The Job Factory is a multi-threaded service responsible for executing jobs requested by users. This service listens for portal job requests from Web Client users, manages program executing and returns results to the requestor. When a job is requested, the Job Factory builds appropriate job control steps to run the job, and return results to the client user through the Web Client and to the Repository for future output distribution. (Brio Technology 2000)

Using this portal design gives users easy and quick access to knowledge by providing an easy-to-use interface, single access point and an intuitive Web browser-like navigation system. This Web-based platform provides an open system architecture that will enable transparent exchange of information between any applications on its platform. It also has a standard user interface, the Web-browser, that provides interoperability between itself and other applications. It has incorporated into its design security measures to ensure only authorized users are accessing the knowledge stored within the system. Because this portal design provides redundancy, is easy to use, interactive and accessible, and uses simple keyword searches, it allows users to make quick, timely, and effective decisions. This portal design also incorporates an open, scalable, and distributed architecture to allow flexibility in integrating with existing IT infrastructures.

D. EXAMPLE OF NPS ISO KNOWLEDGE PORTAL USE

This section compares the new NPS ISO portal to the current process used by IO cell operators to meet requirements, and how the knowledge portal will benefit them by providing an infrastructure that aids in making quick, timely, and effective decisions.

A user could have a requirement request for any open source information that will aid in understanding some countries' threats to the U.S. in a crisis situation. Specifically, the user may request intelligence on the countries' economic and political situation, military status, any present or potential allies, and any other information that would aid in making key decisions in the event of a crisis situation.

The current process of meeting the requirement involves the user conducting extensive research, and numerous searches on different sources (e.g., internet sites, documents, news articles, experts), weeding out irrelevant and obsolete information,

compiling the resulting data and information into some consolidated form to gather the knowledge needed to make the right decisions. This process is time consuming, and each different source requires the user to conduct a detailed search through data and information that may or may not be useful. Figure 4.2 depicts this process.

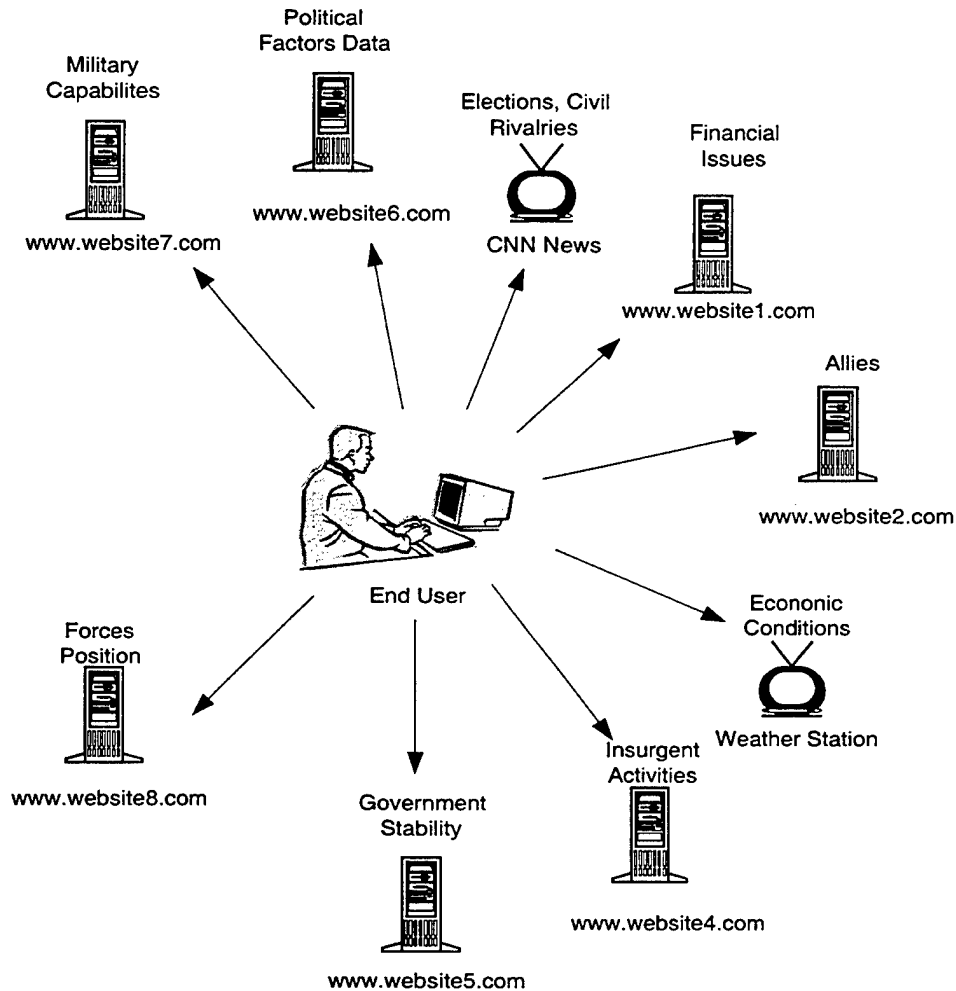


Figure 4.2: Current Process of Gathering Information

For the user, the NPS ISO knowledge portal allows intelligence to be extracted seamlessly from diverse sources. The knowledge worker, or software administrator, will

conduct extensive searches for the requested intelligence. Once this intelligence is gathered, the knowledge portal can be used to organize, formalize and distribute the knowledge to the user. Once the user is ready to access the knowledge, they simply click on a "hot button" created for that requirement, or type in the appropriate search word and the knowledge will appear for the user to analyze.

Not only can the user conduct "one-stop" shopping for relevant knowledge from diverse on-line sources, they also have the capability to extract both explicit and tacit knowledge from NPS faculty and the ISO curriculum. The knowledge portal allows users to arrange teleconferencing times, as well as use the on-line yellow pages to contact subject matter experts in the IO field. Users can also send email to NPS IO faculty experts, or call them. Knowledge within the ISO curriculum is always available for users to browse through to prepare them for making critical decisions. The knowledge workers can also use these resources to communicate with users to ensure that they are satisfied with the information and knowledge made available to them. Knowledge workers can also receive feedback on the effectiveness and efficiency of knowledge transfer. Planning meetings or conferencing times will allow knowledge workers to assess if the knowledge generated is being applied appropriately in the decision making process.

Although most of the information and knowledge that the knowledge portal generates is essentially the same as what the user currently receives, the knowledge portal goes well beyond mere collection and storage of information for the user. It provides a gamut of resources, services and expert advice that equips users with knowledge to make key decisions. This resource saves the user time and provides the knowledge in an organized and meaningful format. Figure 4.3 depicts this process.

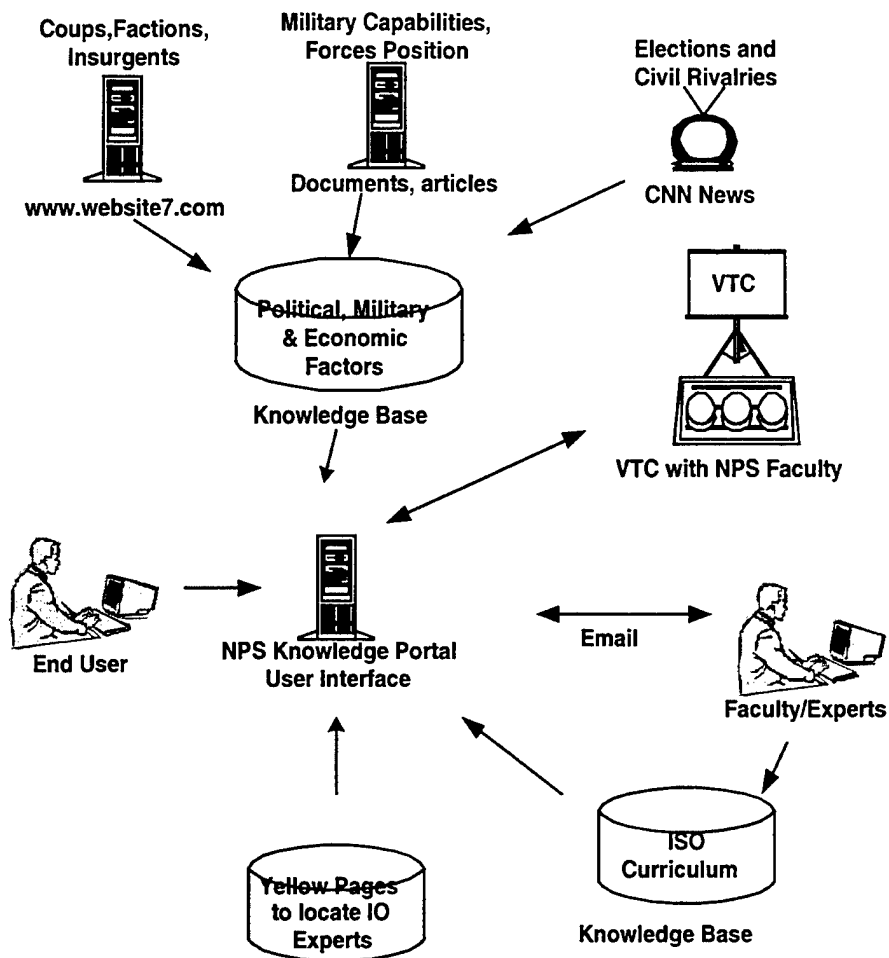


Figure 4.3: NPS ISO Knowledge Portal Example

E. CONCLUSION

This chapter addressed the design of a knowledge portal to be implemented into the NPS ISO curriculum to provide users a Web-based, interoperable, flexible, reliable and secure system that meets their needs. The design technology was generated using the amalgamated KM life cycle. Chapter V will address recommendations and future research opportunities.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

In 1999, Commander, Naval Education and Training (CNET) provided initial funding to make components of the ISO curriculum at NPS available through ADL. The decision to fund this program and make it available to officers who are unable to attend NPS was due to a perceived need to facilitate a broader engagement with the theories and practice of Information Operations throughout the Fleet (Teleologic 2000). The ISO curriculum is especially well suited to the ADL program, and the integration of study with fleet operations, in order that students may benefit from learning through real world situations as they evolve throughout the course.

This also provides an opportunity for IO operators holding key decision-making positions to tap into resources provided within the ISO curriculum that will aid them in understanding potential threats and crisis situations, and gather knowledge to better equip them in making critical decisions at the right time. Providing a knowledge portal into the NPS ISO curriculum is key to IO decision makers being able to tap into these resources with ease and simplicity. It can provide a comprehensive collaboration tool that organizes, formalizes, and distributes open source information and knowledge to users.

The knowledge portal uses the different phases of the amalgamated KM life cycle, as described by Nissen et al, to ensure the most effective information tools and technologies are implemented. This thesis shows how implementing a knowledge portal into the NPS ISO curriculum can provide IO users with knowledge that is timely, up-to-date, and that generates an accurate intelligence picture.

B. RECOMMENDATIONS

A mid-tier, Web-based architecture after Brio technologies as the portal design for the NPS ISO curriculum is recommended. This portal design incorporates the KM life cycle principal enabling information technologies, which identifies the necessary capabilities and tools to design and develop extant KM systems and processes (Nissen, Sengupta and Kamel 2000). This portal design can meet the user requirements by allowing interoperability with other systems, flexibility to adapt to changes in technology and information requirements, reliability to ensure availability of knowledge when needed and security.

Because of its modularity, mid-tier design, web-based architecture and interoperability, this architecture is suited to be integrated in almost any NPS ADL ISO curriculum developed. Extending the knowledge portal to other ADL ISO courses can provide users access to a wider range of tacit and explicit knowledge residing at NPS.

C. FUTURE RESEARCH

The topics presented below are potential areas that require future research. These areas are not addressed in detail in this thesis due to time and scope limitations. However, it is vital that these topics be addressed in detail to support and improve the knowledge portal.

1. Metadata Tags

The key to a successful knowledge portal is the ability of the user to get the right knowledge, at the right time to make the right decisions. In order for this to be successful, the knowledge workers must have a good understanding of how to create and use metadata tags effectively. Metadata tags are commands placed within the head

portion of knowledge objects that aid in proper searching and indexing of the knowledge base. They define the common language used within the knowledge portal so that all users, systems and programs can communicate precisely, eliminating confusion and improper query responses.

Properly constructed metadata give a clear description of knowledge objects and provide complete, detailed and unambiguous results to user search queries. Further research on how to properly create metadata tags, and incorporate some form of metadata dictionary for knowledge workers and users of the knowledge portal, will aid in building a successful knowledge portal.

2. Maintenance of the Knowledge Portal

It is important that the knowledge portal be equipped with a knowledge worker or application that administers services, manages content, and manages user access. The administrator should be responsible for adding, modifying, deleting or reactivating knowledge portal users access and permissions. This ensures that only authorized personnel have access to the knowledge portal, and their access is available at all times. The administrator should also ensure the knowledge base is constantly updated with knowledge that is useful to the users. Adding, modifying and deleting categories and knowledge objects as information becomes available, or obsolete is vital to users making the right decisions in a timely manner. The administrator will also be responsible for the use and implementation of metadata tags as discussed above.

Deciding who, or how this process can best be implemented and carried out is an issue that must be addressed in further detail. The maintenance of the system can be done manually, using a knowledge worker, or by implementing a software program that

will allow knowledge workers ease in managing the entire knowledge cycle from object creation and definition, to knowledge links and end-user accessibility (Brio Technology 2000).

D. FINAL THOUGHTS

The implementation of a knowledge portal into the NPS ISO curriculum offers good potential to aid users in making key decisions in crisis situations. Users will have the advantage of meeting all of their requirements through one consolidated portal that facilitates organizing, formalizing and distributing an array of open source knowledge. Not only that, users will also have access to the ISO curriculum, subject matter experts (through on-line yellow pages and NPS IO faculty), and other knowledge sources that previously weren't available. This collaboration of resources will provide users with access to knowledge that is timely, accurate, usable, complete, relevant, objective and sufficiently detailed to support an array of IO requirements.

LIST OF REFERENCES

- Ackerman, R.K., "Intelligence Architecture Augments Area Expertise With Data Access," *SIGNAL Magazine*, January 2000.
- Brio Technology Technical Brief on Architecture Overview, 2000.
- Brooking, A., *Corporate Memory: Strategies for Knowledge Management*, International Thomson Business Press, 1999.
- Chief of Naval Education and Training Navy Learning Network, "Distributed Learning Information and Initiatives," 1998.
- Chief of Naval Operations Director of Naval Training, "The Navy-Wide Distributed Learning Planning Strategy," December 4, 1998.
- Cho G., Jerrell H., and Landay W., *Program Management 2000: Know the Way*, Defense Systems Management College Press, 2000.
- Davenport, T.H., De Long, D.W. and Beers, M.C., "Successful Knowledge Management Projects," *Sloan Management review*, Winter, pp. 43-57, 1998.
- Davenport, T.H. and Prusak, L., *Working Knowledge: How Organizations Manage What They Know*, Boston, Harvard Business School Press, 1998.
- Department of Defense Implementation Plan for Advanced Distributed Learning, 2000.
- Despres, C. and Chauvel, D., "Mastering Information Management: Part Six-Knowledge Management," *Financial Times*, March 8, pp. 4-6, 1999.
- Doyle, M.P., Deckro, R.F., Kloeber, J.M. Jr., Jackson, J.A., "Measures of Merit For Offensive Information Operations Courses of Action," *Military Operations Research*, Vol 5, Number 2, 2000.
- Firestone J.M., "The Enterprise Knowledge Portal Revisited," White Paper No. Fifteen, Executive Information Systems, Inc, March 15, 2000.
- Gartner Group, "Knowledge Management Scenario," Conference presentation, SYM8KnowMan1098Kharris, 1999.
- Joint Publication 3-13.
- Koulopoulos, T.M., "Corporate Portals: Make Knowledge Accessible To All," *InformationWeek.com*, April 26, 1999.

- Liebowitz, J., ed. *Knowledge Management Handbook*, Washington, D. C.: CRC Press, 1999.
- Meehan, P., "Internet Portals! The Door or the Store?," KA-04-09103 *Gartner Group Research*, July 1998.
- Morris, S., "RACI, Assessing the IO Information Base," *Cyber Sword*, Vol. 4, Number 1, Spring 2000.
- Murray, G., "Enterprise Knowledge Portals to Become the Shared Desktop of the Future," IDC Press Release, March 25, 1999.
- Naval Post Graduate School, "U.S. Naval Postgraduate School Distributed Learning Migration Plan," July 6, 1999.
- Nissen, M.E., "Knowledge-Based Knowledge Management in the Reengineering Domain," *Decision Support Systems*, Special Issue on Knowledge Management, 1999.
- Nissen, M.E., "Redesigning Reengineering through Measurement-Driven Inference," *MIS Quarterly* 22(4), 1998.
- Nissen, M.E., Kamel, M., and Sengupta, K., "Integrated Analysis and Design of Knowledge Systems and Processes," *Information Resources Management Journal*, Jan-Mar 2000, pp. 24-43, 2000.
- O'Dell, C. and Grayson, C.J. Jr., *If Only We Knew What We Know*, New York, The Free Press, 1998.
- Phifer, G., "How Does One Get an Intranet Portal?" *Gartner Group Research Note* (TU-06-4812), December 28, 1998.
- Shilakes, C.C. and Tylman, J., "Enterprise Information Portals," Merrill Lynch, November 16, 1998.
- Teleologic Learning Company, "A Statement of the Problem and a Preliminary Architecture for the Information Systems and Operations Curriculum at the Naval Postgraduate School," April 2000.
- Warner, S., "Internet Portals, What They Are and How to Build a Niche Internet Portal to Enhance the Delivery of Information Services," Collaborative Health Informatics Centre, 1999.

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Naval Postgraduate School
555 Dyer Road, Code SM/Ni
Monterey, CA 93943-5000

4. Dr. Carl R. Jones 1
Professor of Information Systems
Naval Postgraduate School
Monterey, CA 93943

5. Dr. Dan Boger 1
Chair, IS Academic Group
Code IS
Naval Postgraduate School

6. LT Raymond R. Buettner 1
Naval Postgraduate School
589 Dyer Road, Room 200A
Monterey, CA 93943-5000

7. LT Allisa M. Walker 1
11705 Thrasher Ct
Waldorf, MD 20601